Aphicidal activity of Imidacloprid and Primicarb compared with certain plant extracts on *Brevicoryne brassicae* L. and *Aphis craccivora* Koch

Gamal Abdu-Allah
Dept. Plant Protection, Fac. Agric., Assiut Univ., Assiut, Egypt.
Email-Address: gama_eg@yahoo.com

Abstract:
Aphids are very serious pest in greenhouses and field in many countries. The toxicity of two insecticides with different mode of action and three petroleum ether plant extracts were tested against two aphid species; *Brevicoryne brassicae* L, and *Aphis craccivora* koch in the laboratory using leaf-dip bioassay. The toxicity index showed that the carbamate insecticide, primicarb has the highest aphicidal activity. Based on the LC_{50} values, primicarb was the most toxic compound with LC_{50S} of 0.12 and 0.26 mg/L against *B. brassicae* and *A. craccivora*, respectively. Imidacloprid was the least toxic compound against *B. brassicae* with LC_{50} of 2.14 mg/L. Against *A. craccivora*, henbane extract was the least toxic compound (LC_{50}=19.7 mg/L.). The results indicated that field efficiency of primicarb and imidacloprid were compatible with the laboratory results. However, plant extracts showed opposite results under field conditions.

Key words: imidacloprid, primicarb, petroleum ether plant extracts, leaf-dip bioassay, field efficiency.

Introduction

Aphids (Homoptera: Aphididae) cause plant damage

by direct feeding or indirect by transmission of virus diseases. The cabbage aphid, *Brevicoryne brassicae* L. is one of the major pests of vegetable brassicas. The cowpea aphid, *Aphis craccivora* koch is distributed world wide. In Egypt, the cowpea aphid is one of the most important insect pest of legumes such as faba bean, cowpea, pea, lablab … etc. It has been reported to cause considerable loss in yield in different parts of the country (Bishara et al, 1984).

Controlling aphid in crops is very important to increase the quality and quantity of the products. Chemical control is the major effective method that used by farmers. In recent years, selective insecticides, like neonicotinoids were introduced in the market instead of traditional insecticides because insect pests became resistant to the most of conventional insecticides. These selective insecticides are environmentally friendly (Yeh et al., 1997). Primicarb is one of anti-acetylcholine esterase belongs to carbamate group. This

Referees:Prof.Dr.Abdel-Raoof.M.El-Gharib,Prof.Dr.Hosam El-Din .A.I.Ahmad

compound showed a good potency against aphids. However, last years, some researchers found that some aphid species have less susceptibility against primicarb (Rongai et al. (1998) and El-Ghareeb (1993). The information about susceptibility of the two tested aphid species toward primicarb is very important. Imidacloprid is one of neonicotinoid group. It has a broad activity against several sucking insects (Elbert et al, 1998). The mode of action of this group is binding agonistically with the nicotinic acetylcholine receptors in the central nervous system of several pest insects (Nauen et al, 2001).

Using botanical insecticides in pest control in Egypt is not new. Terrestrial plants produce a bewildering array of natural products terpenoids, phenolics, alkaloids-likely exceeding 100,000 novel chemical structures. Many of these are thought to serve on an ecological function for the plants producing them, serving to defend the plants from herbivores and pathogens(Isman and Akhtar, 2007). Few commercialized botanical insecticides are available compared with synthetic insecticides.

Datura is a medicinal plant that belongs to the family solanaceae. Many of medicinal plants have chemical compounds like alkaloids and oxalic acid that considered poisons (Gardner and Pfister, 2007) to human and pests. Poor farmers need safe and cheap way of controlling pests. Botanical insecticides (Greenberg et al, 2005) are more preferred than conventional insecticides as they have little or no negative effect on the agricultural environment (Isman, 2006). The activity of plant extracts against aphids was not so far under the lab and field conditions(Gorur et al, 2008).The objectives of our investigation can be categorized as following:

1- Comparing the activity of two commonly synthetic insecticides and certain plant extracts on cabbage and cowpea aphid species using leaf dip bioassay under laboratory condition.
2- Efficiency of the tested compounds against cabbage aphid in cabbage field.

Materials and methods

Chemicals

The details of insecticides used in this investigation are shown in table 1. The common name, scientific name, family and extraction part of plant used in extraction are noted in table 2. The extraction preparations were done as follow: Fresh seeds of datura and leaves of hebane were collected from Assiut west desert in Upper Egypt. Fruits of black pepper were brought from local market. The fresh plant parts were dried under room temperature. The dried parts were ground in electric mill. About 200 g of dry powder material were extracted in a soxhlet extractor with petroleum ether (500 ml) as a solvent for 6 hours. The solvent

was evaporated at 40-60˚ C using rotary evaporator to become semi-dry material. The crude extract was transferred quantitatively in flask and then kept under 10 C˚ until used for toxicological investigation. The surfactant Triton X-100 (100 % purity, BDH Chem, Ltd. Poole England) imported from England by a local chemical company was used in preparing the extract concentrations.

Table 1. List of the two tested insecticides.

Insecticide	**Trade name**	**Chemical group**	**Formulation type and % a.i.**
Imidacloprid	Gaucho®	Neonicotinoide	70% WS[a]
Primicarb	Aphox ®	Carbamate	50% WDG[b]

[a]WS=Water-soluble concentrates;[b]WDG= water dispersal granule

Table 2. List of plant species used as source of extract using petroleum ether.

Common name	**Scientific name**	**Family**	**Extraction part**
black pepper	*Piper nigrum*	Piperaceae	Fruits
Jimson weed/ datura	*Datura stramonium*	Solanaceae	Seeds
henbane	*Hyoscyamus muticus*	Solanaceae	seeds and leaves

Insects

Aphids used in the bioassay were collected from Assiut University Experimental Farm during 2008/2009 season. *B. brassicae* aphids were taken from cabbage, *Brassica oleracea v. capitata* field, while cowpea aphid, *A. craccivora* population were collected from the field of faba bean, *Vicia faba*.

Laboratory bioassay

The leaf dip-bioassay technique (O'Brien et al., 1992) with little modification was used in the toxicity tests. Five to six concentrations of aqueous solution of each compound plus 0.1% Triton $X\text{-}_{100}$ as a surfactant were prepared. Half concentration of the Triton was applied with cowpea aphid. In each tested concentration, separate batches of at least 20 apterous adults of approximately the same size were dipped for 10 seconds. The treated aphids were allowed to dry at room temperature for about half an hour. Control batches of aphids were similarly dipped in a solution of distilled water plus the surfactant. After the treated batches of aphids had dried, they were individually transferred to petri dishes(9 cm diameter) and held for 48 hours at 22+2°C, 60+5 RH and photoperiod 12:12 (L:D). Aphid mortality was recorded 48 hours after treatment with a binocular microscope. An aphid was considered dead if it was incapable of coordinated forward movement. The toxicity experi-

ment of each compound was repeated twice. Results were corrected by Abbott's formula (Abbott, 1925); LC_{50} and slope values were determined by a computerized probit analysis program.

Field experiment

The field tests were conducted on cabbage heads of *Brassica oleracea v. capitata* at Assiut University experimental Farm, Assiut, Egypt. The cabbage seedlings were cultivated on September, 15^{th} at 50 cm distance. Normal agricultural practices were applied. The experimental area was divided into plots of 10 m^2. The experiment was arranged in complete randomized design (CRD) with threereplicates. Spraying application of tested compounds was done on December 31, 2008 in a clear day without wind. The knapsack sprayer with one nozzle covering 476 liter per hectar was used in application. The extracts and insecticides were diluted with tap water and Triton $X\text{-}_{100}$ was added at rate of 0.1 % as detergent. The aphid populations were counted in three external leaves in the marked heads before spraying at interval period 1, 5 and 10 days. The % reductions were calculated according to the equation of Henderson and Tilton (1955).

Results and discussion

Data represented in tables 3 & 4 showed that primicarb insecticide was the most toxic compound against cabbage and cowpea aphids followed by black pepper extract. Whereas, the LC_{50} values of primicarb and black pepper extract were 0.12 and 1.15; 0.26 and 0.31mg/L for cabbage and cowpea aphids, respectively. Based on the toxicity index, primicarb was more toxic than imidacloprid by 17.83 fold. The toxicity of the tested insecticides was almost similar against the two tested species; where as the maximum difference in the toxicity against the two tested aphids was around two fold for primicarb. Our results were in the opposite with the results reported by Nauen et al. (1996) where they found that imidacloprid was more active than primicarb by 23 fold aginst *Myzus persicae* using dipping bioassy technique.

Table 3. Toxicity of two insecticides with different mode of actions and three plant extracts on cabbage aphid, *Brevicoryne brassicae* after 48 hrs using leaf-dip bioassay technique.

Compounds	LC_{50} mg/L (95 %FL)	Regression equation	Toxicity Index*
Insecticides			
Imidacloprid	2.14 (0.85-4.21)	Y=-0.41+1.24x	5.61
Primicarb	0.12 (0.008-0.18)	Y= 1.61+1.75x	100.00
Plant Extracts			
Black pepper	1.15 (-)¤	Y= 4.89+1.74x	10.43
Datura	1.23 (0.19-8.79)	Y=-0.09+0.96x	9.76
Henbane	1.38 (-)¤	Y= 4.52+1.20x	8.70

*: Toxicity Index **(Sun, 1950)**, (LC_{50} of the most toxic tested compound / LC_{50} of the tested compound)*100 (-)¤ undetected

Table 4. Toxicity of two recent insecticides with different mode of action and three plant extracts on cowpea aphid, *Aphis craccivora* koch after 48 hrs using leaf-dip bioassay technique.

Compounds	LC_{50} mg/L (95 %FL)	Regression equation	Toxicity Index*
Insecticides			
Imidacloprid	2.04 (1.23-2.70)	Y=0.40+1.28x	12.75
Primicarb	0.26 (0.23-0.30)	Y=1.41+2.42x	100.00
Plant Extracts			
Black pepper	0.97 (0.24-12.44)	Y=0.02+1.28x	26.80
Datura	2.77 (-)¤	Y=0.06+1.20x	9.39
Henbane	19.07 (0.84-171)	Y=-0.56+0.56x	1.36

*: Toxicity Index **(Sun, 1950)** , (LC_{50} of the most toxic tested compound / LC_{50} of the tested compound)*100(-)¤ undetected

In the present study, black pepper, datura and henbane extracts exhibited aphicidal activity against the two aphid species. Primicarb showed more potency than black pepper, datura, and henbane extracts by 9.58, 10.25, and 11.50 fold, respectively, on cabbage aphid. Primicarb was also more toxic than the same corresponding plant extracts by 3.73, 10.65, 73.35 fold on cowpea aphid, respectively. The toxicity of all tested extracts against the two aphid species was almost the same except for henbane. Cowpea aphid showed more resistance than cabbage aphid against henbane by 14 fold (table 3&4). According to tables 3&4, primicarb was the only compound which had a high slope value *(s*lope=2.42) with *A. craccivora,* while the rest of tested compounds exhibited relatively low slopes (slope<2).These results indicate that the two populations of tested aphid species were highly homogenous in responding to primicarb. The other compounds were varied in the homogeneity. More heterogeneity was observed in responding in the case of henbane with *B. brassicae* and *A. craccivora*.

Some investigation on other pests confirmed the present results. Soliman et al(2005)found high activity of crude extracts by hexane,diethyl ether, ethyl acetate of *Hyoscymus muticus* against *Aphis gossypii* Glov. The LC_{50} values of these extracts were 0.73, 0.88 and 1.01 mg/cm^2, respectively. Many authors tested the medicinal and ornamental plant extracts toward different aphid species under laboratoy conditions (Moawad and Al-Barty, 2011; Salari et al, 2010). The aphicidal and growth inhibition effects of nemazal on *A. craccivora* were investigated by Dimetry and El-Hawary, 1995. Extraction of *Piper nigrum* fruit by methanol contains pellitorine, guineensine, pipercide, and retrofractamide A. These compounds have a mosquitocidal effect (Shaalan et al, 2005). The acute toxicity of the tested plant extract can be explained where fruits of black pepper, *Piper nigrum* L. contain piperin, the insecticidal alkaloids.

Piperin is an alkaloidal amide of oleoresin of pepper (Matsubara and Tanimura,1966). The efficacy of datura extracts in the present study may be due to its alkaloidal constituents such as hyoscine, atropine and hoscyamine which have neurotoxic effects(Bruneton,1995). Atropine and hoscyamine have also physiological activity. Atropine is an inhibitor of muscarinic receptors of peripheral organs innervated by the parasympathetic post gangelionic fibers.

Data represened in figure 1 showed that primicarb provided high effeciency against cabbage aphid under field conditions compared with the rest compounds. Otherwise

imidacloprid at 47.6 g ha^{-1} provided similar control to 125 g ha^{-1} of primicarb at 1, 5 and 10 days after spraying application.

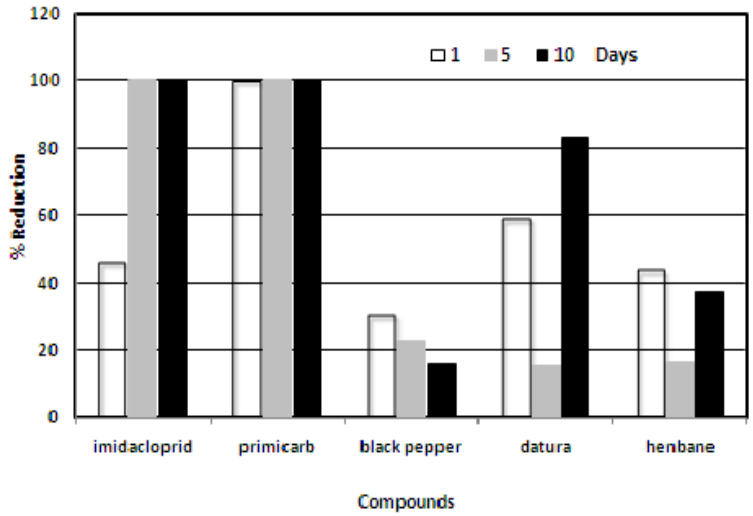

Figure 1. Mean reduction percentages in cabbage aphid, *Brevicoryne brassicae* L. population that infesting cabbage plants as a result of treatments with primicarb 125 g a.i/hectare, the rest compounds in 47.6 ga.i/ hectareunder field conditions.

Inspite of black pepper, datura and henbane extracted by petroleum ether showed high potency against the two aphid species in laboratory, the field results were the opposite. Successful pest control by foliar application not simply related to systematic behaviour alone but it depened on phesico-chemical characteristics of the active ingredient, the plant species(eg.,different barrier, properties of cuticles), metabolism and functional morphology of the pest species considered(Buchholz and Nauen,2001). Environmental factors such as ultraviolet light, temperature, PH and microbial activity play important role in natural products degradation under field conditions. Leatemia and Isman, 2004 reported that using the same seed extraction process, the insecticidal potency of some seed extraction are varied from regions and annual in Indonsia. Isman (2006) Suggest that there must be some degree of chemical standardization for botanical insecticide, presmably based on the putative active ingrdient to provide a reiable level of effeciacy. In most cases, the crude extractions contain low concentration of active ingredients. Iqbal et al, 2011 found reduction in wheat aphid infestation after application of water hot pepper, *Capsicum frutescens* extracts. Many of the plants discussed in this study are tropical in distribution and

available to growers in developing countries. It is time to refocus on the development and application of known botanicals rather than screen more plants and isolate further novel bioactive substances.

In conclusion, the battle to control aphids will continue as long as these pest compete with mankind for food recourses. Laboratory screening of the potency of crude plant extracts on pests is essential. The second step is isolation and identification of the active ingredients in those extracts. Even though, crude extracts may be easiest and cheapest for the farmers compared with the active ingredient formulations. More polar and non-polar extracts of the tested plant need to evaluate. The primicarb and imidacloprid still provide good efficacy in the field control.

Acknowledgments

The author wishes to thank the Plant Protection Dept., Fac. of Agriculture, Assiut University about continuous supporting. Thanks also extended to Dr. Yossif Omar, lecturer at the same dept. for his help in collecting field data. My thanks introduced to Professor Dr. Mohamed Fouad Professor in Horticulture dept. in our college for his facilities in cabbage field experiment.

References

Abbott, W.S. (1925). A method of computing the effectiveness of an insecticide. J. Econ. Entomol. 18: 265–267.

Bishara, S.I.; Farm, E.Z.; Attia, A.A. and El-Hariry, M.A.1984. Yield losses of faba bean due to aphid attack. Fabis News Letter no.10.

Bruneton,J.1995. harmacognosy, phytochemistry of medicinal plants. Intercept Ltd England UK.

Buchholz, A. and Nauen, R. 2001.Translocation and translaminer bioavailability of two neonicotinoid insecticides after foliar application to cabbage and cotton. Pest Mang Sci 58:10-16.

Dimetry, N.Z. and El-Hawary, F.M.A.1995. Neem Azal-F as inhibitor of growth and reproduction in the cowpea aphid, *Aphis craccivora* koch. J Appl Ent 119:67-71.

Elbert, A; Nauen, R. And Leicht, W. 1998. Imidacloprid, a novel chloronicotinyl insecticide: biological activity and agriculture importance, in Insecticide with mode of action: Mechanism and application, ed by Ishaaya I and Degheele D, Springer Verlag, Berlin, Heidelberg, pp 50-74.

El-Ghareeb, A. M. 1993. Biochemical mechanism of resistance of cotton aphids to carbamate insecticides. 5th Nat. Conf. of Pests & Dis. Of Veg. & Fruits in Egypt, Ismailia. 1:46-64.

Gardner, D. R. and Pfister, J. A. 2007. Toxic alkaloid concentrations in *Delphinium nuttallianum, Delphinium andersonii*, and *Delphinium*

geyeri in the intermountain region. 2007 Rangeland Ecology & Management 60: 441-446.

Greenberg, S. M., Showler, A.T., Liu, T. X. 2005. Effects of neem-based insecticides on best armyworm (Leopidoptera: Noctuidae). Insect Science 12: 17-23.

Henderson, C.F. and Tilton, E.W.1955. Tests with acaricides against the brown wheat mite. J Econ Entomol 48:157-161.

Iqbal,M.F.;Kahloon,M.H.;Nawaz , M.R.and Javaid, M.I. 2011. Effectiveness of some botanical extratactes on wheat aphids.J of Animal and Plant Sciences 21:114-115.

Isman, M. B., 2006. Botanical insecticides, deterrents, and repellents in modern agriculture and an increasingly regulated world. Ann Rev Entomol 51: 45-66.

Isman, M.B. and Akhtar, Y. 2007. Plant natural products as a source for developing environmentally acceptable insecticides. pp 235-247: In Insecticide design using advanced technologies. Ed.by Ishayya, I; Nauen, R and Horowitz, R. pp. Springer-Verlag Berlin Heidelberg.

Leatemia,J.A. and Isman, M.A. 2004. Insecticidal activity of crude seed extracts of *Annona spp., Lansium domesticum* and *Sandoricum koetjape* aginst lepidopteran larvae. Phytoparasitica 32:30-37.

Matsubara, H. And Tanimura, R.1966. On the utilization of constituents of pepper as an insecticide and pyrethrins or allethrin synergist. Studies on synergist for insecticides XXIV. Btyu-Kagaw. 31:162-167.

Moawad, S. S. and Al- Barty, A. M.F.2011. Evaluation of some medicinal and ornamental plant extracts toward pomegranate aphid, *Aphis punicae*(Passerini) under laboratory conditions. African Journal of Agriculture research. 10:2425-2428.

Nauen, R.; Ebbinghaus-Kintscher, U.; Elbert, A.; Jeschke, P.and Tietjen,K. 2001. Acetylcholine receptors as sites for developing neonicotinoid insecticides, In Biochemical Sites Important in Insecticide Action and Resistance, ed by Ishaaya I, Springer Verlag, Berlin, pp 70-105.

Nauen, R.; Strobel, J.; Tietjen, K.; Otsu, Y.; Erdelen, C. And Elbert, A. 1996. Aphicidal activity of imidacloprid against a tobacco feeding strain of *Myzus persicae*(Homoptera: Aphididdidae) from Japan closely related to *Myzus nicotianae* and highly resistant carbamate and organophossphates. Bull Entomol Res 86: 165-171.

O'Brien, P.J.; Abdel-Aal, Y.A. ; Ottea, J.A. and Graves,

J.B.1992. Relationship of insecticide resistance to carboxylesterases in *Aphis gossypii* (Homoptera: Aphididae) from Midsouth cotton. J Econ Entomol 85:651-657.

Rongai, D.; Cerato, C.; Martelli, R. and Ghedini, R. 1998. Aspects of insecticides resistance and reproductive biology of *Aphis gossypii* Glover on seed potatoes. Potato Research 41: 29-37.

Salari, A.; Ahmadi, K. And Zamani. R. 2010. Study the effect of acetonic extract of *Otostegia persica* (Labiate) on three aphid species and one storied product pest. Advances in Environmental Biology. 4: 346-349.

Shaalan, E.A.; Canyon, D.; Younes, M.W.F.; Abdel-Wahab,H.; Mansour,A. 2005. A reviw of botanical phytochemicals with mosquitocidal potential. Environment International 31:1149-1166.

Soliman,M,M.,M. ; Hassanein, A.A. and Abou-Yousef, H.M. 2005. Efficiency of various wild plant extracts against the cotton aphid, *Aphis craccivora* Glov.(Aphididae: Homoptera).Acta Phytopathologica et Entomologica Hungarica 40(1-2):185-196.

Sun, Y.P. 1950. Toxicity indexes an improved method of comparing the relative toxicity of insecticides. J Econ Entomol 43:45-53.

Yeh K.W.; Lin M.I.; Tuan S.J.; Chen Y.M.; Lin C.Y. and Kao S.S. 1997. Sweet potato, *Ipomoea batatas* trypsin inhibitors expressed in transgenic tobacco plants confer resistance against *Spodoptera litura*. Plant Cell Rep. 16:696–699.

Assiut J. of Agric. Sci., 43 No.(1) (104-114)

فاعلية مبيدي الاميداكلوبريد والبريميكارب مقارنة مع بعض المستخلصات النباتية على نوعين من حشرات المن

د/جمال عبد اللطيف محمد عبد الله
قسم وقاية النبات- كلية الزراعة- جامعة أسيوط
البريد الالكترونى: gama_eg@yahoo.com

يعتبر المن آفة خطيرة في الصوب الزجاجية والنباتات الحقلية في معظم البلاد . تم اختبار سمية مبيدى اميداكلوبريد وبريميكارب وثلاث مستخلصات نباتية استخلصت بالأثير بترولي ضد نوعين من المن هما من الصلييبات ومن البقوليات في المعمل باستخدام طريقة الغمر – أوضح دليل السمية أن البريميكارب أكثر المبيدات سمية بناءا على قيم التركيزات السامة النصفية ، أظهرالبريميكارب انه اقوي المبيدات المختبرة سمية حيث أن قيمة التركيزات السامة النصفية تساوى 0.12 و 0.26 جزء في المليون ضد من الصلييبات ومن البقوليات على التتابع – بينما مبيد الاميداكلوبريد اظهر انه اقل سمية ضد من البقوليات بقيمة تركيز سام نصفى 2.14 جزء في المليون مستخلص السكران اظهر سمية منخفضة. أظهرت نتائج الاختبارات الحقلية تفوق المبيدات المصنعة عن المستخلصات النباتية.

كلمات افتتاحية:
اميداكلوبريد-بريمياكارب- مستخلصات الايثير البترولى- طريقة الغمر- التقييم الحقلى.